

REMARKS

Claims 1-5 are active in the case. Reconsideration is respectfully requested.

Applicants' representative wishes to thank Examiner Zalukaeva for the helpful and courteous interview of November 7, 2003. As a result of the discussion, it is believed that the prosecution of the application has been materially advanced and that the issues in the case have been clarified.

The present invention relates to a process of preparing a block copolymer having at least one polymer block comprising an acrylic acid ester.

Invention

As claimed, the present invention is directed to a process for the preparation of acrylic acid ester polymer by the polymerization of an acrylic acid ester monomer in the presence of an organolithium compound initiator and an organoaluminum compound having the formula: $\text{AlR}^1\text{R}^2\text{R}^3$, wherein R^1 is a substituted or unsubstituted alkyl group containing at least 3 carbon atoms, a substituted or unsubstituted alkoxy group containing at least 3 carbon atoms or a substituted or unsubstituted aryloxy group, and R^2 and R^3 each independently is a substituted or unsubstituted aryloxy group or together form a substituted arylenedioxy group.

The present invention is an industrially advantageous process for the polymerization of acrylic acid ester monomer by anionic polymerization at a high polymerization rate while achieving high living properties. The polymer product obtained results in an acrylic acid ester polymer product having a desired molecular weight and a narrow molecular weight distribution with good reproducibility.

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Reply to the Office Action of June 24, 2003

Prior Art Rejection

Claims 1-5 stand rejected based on 35 USC 103 as obvious over Wang et al, U.S. Patent 5,656,704. This ground of rejection is respectfully traversed.

Applicants reiterate that a proper understanding of the present invention is found in the context of the well known differences to those of skill in the art of the polymerizability of acrylate monomers as opposed to methacrylate monomers in anionic polymerization. As applicants have stated previously, the discussion of the technical background of the invention on pages 1-6 of the specification describes in detail the difficulties of polymerizing acrylic acid ester monomer using an organolithium initiator in the presence of an organoaluminum compound under the very low temperature conditions stated. That, in fact, very significant difficulties are encountered in the anionic or living polymerization of acrylate ester monomers, as opposed to methacrylate ester monomers, is clearly taught and affirmed in the documents which accompany this response and which were discussed at the interview. The documents are:

-- i) ANIONIC POLYMERIZATION, Principles and Practical Applications, H.L. Hsieh, R.P. Quirk, 1996. The document at page 643, the bottom half of the page, states that it has been difficult to establish anionic polymerization conditions for controlled polymerization of acrylate monomers because they are more reactive than methacrylate monomers, and also because the resulting polyacrylates have enolizable hydrogen atoms along the polymer backbone which react with the propagating chain-end ester enolate anions to form the corresponding in-chain ester enolate anions.

-- ii) J.S. Wang, R. Jerome and P. Teyssie, J. Phys. Org. Chem., (1995), 8(4), 208-21.

Table 4 on page 212 of the document shows that, whereas for the MMA-tBuMA monomer pair,

the living character of the combination is indicated as “yes”, for the MMA-tBuA monomer pair, the living character of the combination is indicated as “no.” Clearly, the two monomer pairs, whose difference solely is on the basis of acrylate versus methacrylate, are not in any equivalent in anionic polymerization.

-- iii) M.T. Reetz, S. Hütte and R. Goddard, *J. Phys. Org. Chem.*, (1995), 8(4), 231-241.

The publication at page 236, right column states that one (of skill) expects more alcohol to be formed in the anionic polymerization of butyl acrylate because polymerization of this monomer is known to be more susceptible to “backbiting” than the polymerization of MMA.

-- iv) M. Janata and L. Lochmann, *Makromol. Chem.*, 191, 2253-2260 (1990). This document, in the first paragraph of the Introduction expressly states that the polymerization of acrylates has been studied much less than that of methacrylates for the reason that the more complicated polymerization process generally yields polymers of broad molecular weight distribution; the main reason being the termination reactions of the carbonyl group or transfer reactions that are attributable to the acidic hydrogen atom in the α -position to the carbonyl group.

-- v) S.K. Varshney, R. Jerome, P. Bayard, C. Jacobs, R. Fayt and P. Teyssie, *Macromolecules*, 25(18), 4457-4463, (1992). The document at page 4457, left column, line 6 mentions that the anionic polymerization of (meth)acrylate monomers has its limitations because of possible nucleophilic attack by organoLi compound at carbonyl groups of the polymer and attack at the α -hydrogen atom of the **acrylates** (monomer).

-- vi) H. Yasuda and E. Ihara, *Makromol. Chem. Phys.*, 196(8), 2417-2441 (1995). This document on page 2425 states that it has been difficult to successfully achieve the anionic polymerization of alkyl acrylates because of chain transfer reactions or termination reactions that

occur because of the sensitivity of the acidic alpha proton to nucleophilic attack.

-- vii) P. Vicek, L. Dvoranek, J. Otoupalova and L. Lochmann, *Polymer Bulletin*, 34, (1995). This publication on page 1, the last few lines, states that in the polymerization of 2-ethylhexyl- or butyl acrylate, the stabilizing effect of a ligating system is not high enough to ensure the quantitative and living polymerization (of the monomers).

-- viii) Y. Hosokawa, M. Kuroki, T. Aida and S. Inoue, *Macromolecules*, 24(4), (1992). This document on page 824, left-hand column, states that in the polymerization of acrylic esters, suppression of the secondary reaction is much more difficult because of the presence of the acidic α -hydrogen atom.

Clearly, the polymerization of acrylic acid ester monomer by living polymerization poses problems unique to the acrylate monomer which are not encountered in the polymerization of methacrylate monomer.

Applicants submit that the disclosure of the Wang et al patent is consistent with the discussion above in that the patent discloses the polymerization **only** of one monomer which is methyl methacrylate. No other alkacrylate monomer other than methacrylate is disclosed and certainly there is no teaching or suggestion of the polymerization of acrylate monomer. The teachings of the patent are also consistent with other prior art of record, but not applied, particularly Wang et al, *Macromolecules*, **1994**, 27, 4890-4895, wherein in column 1 of page 1 it is stated: "Devising a living system for the anionic (co)polymerization of (meth)acrylates has been a long-standing problem in polymer synthesis ..." and "... These ligands are mostly effective in promoting the living anionic polymerization of alkyl methacrylates and bulky acrylates; the one of primary acrylates is however still a difficult challenge." Further, as pointed out

previously, Vuillemin et al '909 states that it is well known that the anionic polymerization of alkyl (meth)acrylates **normally** proves difficult because of the occurrence of secondary reactions which, in particular, include reactions of the ester groups of the monomer reactants and reactions involving the α hydrogen atom of the acrylate component of acrylic acid ester monomer reactants.

In light of the discussion above, and the number of publication submitted and discussed above, it is therefore believed clear that one of skill in the art, knowing the problems of attempting to polymerize acrylate monomers, particularly primary alkyl acrylate monomers, by anionic polymerization would not be led by the Wang et al patent to conclude that method of polymerization disclosed therein, **solely for the polymerization of methyl methacrylate**, would be useful for the successful polymerization of acrylic acid ester monomers to the extent that the desired acrylate polymer product is obtained in much higher selectivity than before and in a good (narrow) molecular weight distribution.

The Examiner points to the structural similarities of acrylate monomers and methacrylate monomers, noting that they differ by hydrogen substitution versus methyl substitution, and takes the position that the case law that has developed on compounds which differ only on the basis of homology is relevant to establish a *prima facie* case of obviousness in the present case. Applicants, however, do not concur. It is pointed out that the case law that has developed with respect to the matter of structural isomers and adjacent homologs of similar compounds pertains to the essential question of effectively distinguishing compounds that are structural isomers or adjacent homologs from each other. In order to distinguish compounds that differ, for instance, only on the basis of methyl versus ethyl substitution, evidence must be presented to rebut a

presumed expectation that structurally similar compounds have similar properties. However, the present situation differs from the developed case law because the case law does not apply to processes in which particular reactants are employed. That is, in the present case, the claimed process is limited to the anionic polymerization of acrylate esters, whereas the process of Wang et al is limited to methyl methacrylate as the monomer of the disclosed polymerization reaction. Thus, the two processes are distinct based on the fact that different monomers are used, i.e., methyl methacrylate versus acrylic acid ester. Moreover, it is noted that of the many examples of polymerization reactions disclosed in Wang et al, only Example 24 describes an organoaluminum compound within the scope of the present claims, which compound is i-butyldiaryloxyaluminum. However, this compound is only used in a reaction system in which methyl methacrylate is polymerized and not an acrylic acid ester. Given the art recognized differences involving the polymerization of acrylate versus methacrylate monomers, applicants submit that one of skill in the art would not be led by Wang et al to expect that the process disclosed therein would provide conditions for the anionic polymerization of acrylate ester monomer that result in a superior polymer product characterized by improved molecular weight distribution normally obtained in the anionic polymerization of acrylic acid ester monomers.

The Examiner queried how applicants process of polymerizing acrylate ester monomer is different from Wang et al's polymerization of methyl methacrylate using the same organolithium compound and organoaluminum compound in view of the decision in In re Sussman, 60 USPQ 538 (1944)? In fact, the fact situation described in the cited decision is not the same as in the present case, because in the situation in Sussman, there were **no** differences in process limitations between the claimed process on appeal and the cited and applied prior art

for producing an acetal product in that the same reactants of an acetal and a dihydric alcohol were employed. In other words the “conditions” were the same. The same is not true in the present case. That is, the conditions described in Wang et al of anionically polymerizing methyl methacrylate in the presence of organolithium compound and organoaluminum compound **are not the same** as the conditions of the present process claims because a different reactant is used, i.e. **acrylic acid ester**, not methacrylate ester. This difference is **the critical and significant distinction** between the process disclosed in Wang et al and the present process. The decision of In re Sussman, therefore, does not control in the present situation.

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It is believed that the application is in proper condition for allowance. Early notice to this effect is earnestly solicited.

Respectfully submitted,

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